Added value of speckle tracking in the evaluation of cardiac function in patients with sickle cell disease

Speckle tracking echocardiography is a new means of evaluating cardiac function. The principle of speckle tracking is to measure myocardial strain, based on local shortening, lengthening and thickening of the muscles.

It has been proposed that the left ventricle global longitudinal strain (LV-GLS) could be a useful tool for the detection of early systolic dysfunction in patients under cardiotoxic chemotherapy (Thavendiranathan *et al*, 2014). Moreover, the high reproducibility of the LV-GLS represents an advantage over the left ventricle ejection fraction (LVEF) (King *et al*, 2016; Medvedofsky *et al*, 2017). Compared to the LVEF, the LV-GLS is less affected by changes in loading conditions, which makes it a potentially useful tool in patients with sickle cell disease (SCD), due to the chronic overload associated with SCD. However, in this population, studies are rare and results are conflicting (Ahmad *et al*, 2012; Sengupta *et al*, 2012; Barbosa *et al*, 2014; Hammoudi *et al*, 2014).

The primary aim of our study was to determine whether the LV-GLS was abnormal in a monocentric population of adults with SCD, compared to a matched population of healthy individuals. The secondary aim was to investigate correlations between the echocardiographic parameters and the biological and clinical evaluations of patients with SCD. The institutional Ethics Committee approved the protocol. All patients provided informed consent.

We prospectively included 37 patients with SCD and 34 healthy, age- and sex-matched controls. The patient and control groups were similar in age (31 ± 10 years vs. 32 ± 10 years, respectively).

The LVEF was significantly lower in the SCD group than in the control group (Teicholz: 61·8% vs. 67·6%; $P = 0·05$; Simpson: 61·9% vs. 69·3%; $P < 0·05$; Table I). However, only one patient had a Simpson LVEF < 50%. The left ventricular (LV) mass and LV end diastolic diameter (LVEDD) were higher in the patient group (LV mass: 107 g/m^2 vs. 70 g/m^2, $P < 0·05$ and LVEDD: 53 mm vs. 46 mm; $P < 0·05$). The myocardial performance index was higher (higher values indicate impaired LV function) in the patient group compared to the control group (0·38 vs. 0·27; $P < 0·05$). The LV-GLS was significantly lower in the SCD group than in the control group (−19·4% vs. −22·4%; $P < 0·05$), and it was abnormal (strain > −18%) in 8 (21%) patients of the SCD group. Diastolic function was abnormal in three SCD patients (8%), but normal in the entire control group. The tricuspid regurgitation velocity was higher in the SCD group than in the control group (2·24 m/s vs. 1·96 m/s, $P < 0·05$). However, no patient had pulmonary hypertension.

The multivariate analysis results (Table II) showed that only the LV-GLS and LVEDD remained significantly different between groups.

Among patients with SCD, the mean Hb was 94 g/l (range: 61–122 g/l) and the mean HbF was 12·7% (range: 1–28·6%). The mean ferritin level was 644 µg/l (range: 13–7267 µg/l). Iron overload, defined as a ferritin level greater than 1000 µg/l, was observed in five patients. The mean N-terminal pro b-type natriuretic peptide (NTproBNP) level was 154 pg/ml (range 12–1685 pg/ml). The mean patient walking distance was 66% of the predicted value (range: 33–88%).

Table I. Univariate analysis results show differences between SCD and healthy controls.

Parameter	Control	SCD	*P*
LVEF-Teicholz (%)	67·6 ± 6·9	61·8 ± 6·2	<0·05
LVEF-Simpson (%)	69·3 ± 5·3	61·9 ± 7·2	<0·05
LVEF < 50%	0	1 (2·7%)	
MPI	0·27 ± 0·08	0·38 ± 1·2	<0·05
LV-GLS (%)	−22·4 ± 2·8	−19·4 ± 2·4	<0·05
LV-GLS < 18%	0	8 (21%)	
TRV (m/s)	1·96 ± 0·21	2·24 ± 0·25	<0·05
E/A	1·63 ± 0·35	1·57 ± 0·4	NS
E′ (m/s)	0·16 ± 0·03	0·15 ± 0·04	NS
E/E′	5·64 ± 1·34	6·44 ± 1·76	NS (0·054)
DT (ms)	187 ± 36	194 ± 37	NS
Diastolic dysfunction	0	3 (8%)	NS
LVEDD (mm)	46 ± 4·9	53 ± 5·1	<0·05
LV mass (g/m^2)	70 ± 2·8	107 ± 4·5	<0·05
LVH	0	18 (48%)	<0·05

Results are expressed as the mean ± standard deviation.
DT, deceleration time of E mitral wave; E′, early diastolic mitral annular tissue Doppler velocity; E/A, early peak diastolic velocity of the mitral inflow/late peak diastolic velocity of the mitral inflow; E/E′, ratio between peak velocities of mitral E wave and early-diastolic mitral annulus; LV mass, left ventricular mass; LV-GLS, left ventricle global longitudinal strain; LVEDD, left ventricular end-diastolic diameter; LVEF, left ventricular ejection fraction; LVH, left ventricular hypertrophy; MPI, myocardial performance index; NS, not significant; SCD, sickle cell disease; TRV, maximal tricuspid regurgitation velocity.

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Table II. Multivariate analysis results show factors significantly related to SCD.

Factors	Control	SCD	*P* multivariate
LVEF-Teicholz (%)	67·6 ± 6·9	61. 8 ± 6·2	NS
LVEF-Simpson (%)	69·3 ± 5·3	61·9 ± 7·2	NS
MPI	0·27 ± 0·08	0·38 ± 1·2	NS
LV-GLS (%)	−22·4 ± 2·8	−19·4 ± 2·4	<0·05
TRV (m/s)	1·96 ± 0·21	2·24 ± 0·25	NS
E/A	1·63 ± 0·35	1·57 ± 0·4	NS
E′ (m/s)	0·16 ± 0·03	0·15 ± 0·04	NS
E/E′	5·64 ± 1·34	6·44 ± 1·76	NS
DT (ms)	187 ± 36	194 ± 37	NS
LVEDD (mm)	46 ± 4·9	53 ± 5·1	<0·05
LV mass (g/m²)	70 ± 2·8	107 ± 4·5	NS
LVH	0	18 (48%)	NS
Diastolic dysfunction	0	3 (8%)	

Results are expressed as the mean ± standard deviation.
DT, deceleration time of E mitral wave; E′, early diastolic mitral annular tissue Doppler velocity; E/A, early peak diastolic velocity of the mitral inflow/late peak diastolic velocity of the mitral inflow; E/E′, ratio between peak velocities of mitral E wave and early-diastolic mitral annulus; LV mass, left ventricular mass; LV-GLS, left ventricle global longitudinal strain; LVEDD, left ventricular end-diastolic diameter; LVEF, left ventricular ejection fraction; LVH, left ventricular hypertrophy; MPI, myocardial performance index; NS, not significant; SCD, sickle cell disease; TRV, maximal tricuspid regurgitation velocity.

A correlation was found between the ferritin level and the LVEF ($P = 0{\cdot}04$) and the LVEF and LV-GLS ($P = 0{\cdot}027$). No correlation was found between NTproBNP level and LVEF ($P = 0{\cdot}569$) NTproBNP and LV-GLS ($P = 0{\cdot}859$), walking distance test and LVEF ($P = 0{\cdot}2$) and walking distance test and LV-GLS ($P = 0{\cdot}106$).

Our study showed that GLS was a more powerful index of systolic function than LVEF in patients with SCD. Indeed, the GLS was abnormal in 8 (21%) of 37 patients; in contrast, the LVEF was abnormal in only one of these patients. We could not find a correlation between LV-GLS and the walking distance test or the NTproBNP level. The small number of patients included in the study might explain these results. Furthermore, walking distance test can also be influenced by anaemia, as could be NTproBNP level (Karakoyun *et al*, 2017).

We conclude that the LV-GLS, an emerging sensitive and reproducible parameter of systolic function, appeared to be an effective tool for the detection of early systolic dysfunction in patients with SCD.

However, the clinical impact of an altered LV-GLS in patients with SCD remains to be assessed: larger studies, with a longer follow-up, should be conducted to confirm our results and to evaluate whether LV-GLS might have prognostic implications and whether it should be recommended in routine evaluations of these patients.

Author's contributions

MM, MAA, and AE designed the study; MM and TBH performed the research; MM and JCR analysed the data; MM and JCR wrote the paper. All authors were involved in manuscript preparation and approved the final version of the manuscript.

Conflict of interest disclosure

None.

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